GENETIC CORRELATIONS BETWEEN MILK PRODUCTION AND MEAT PRODUCTION TRAITS IN MILKING SHORTHORN CATTLE

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PREFACE

This research was conducted by the USDA from 1932 to 1961. From 1953 to 1961 the research was conducted in cooperation with the U.S. Northeastern Prison, Bureau of Prisons, Lewisburg, Pa.

Estimates of genetic correlations among several milk and meat production traits are being published to aid in determining whether selection for some traits in a breeding program will tend to have favorable or adverse effects on other traits. The results of this research are still applicable at present date.

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INTRODUCTION

A knowledge of the genetic relationships between lactation and growth and carcass traits in cattle is basic to an understanding of the degree to which excellence in desired characters can be combined in the same animal. The magnitude of positive or negative associations among traits is a major factor in determining whether the beef and dairy industries should use specialized types or dual-purpose types. A question of equal importance relates to the indirect effects, if any, of intense selection for milk production on the meat characteristics and value of surplus male dairy calves.

In this study, estimates of genetic correlations among several milk and meat production traits were made. This information, when added to estimates previously reported in the scientific literature, should aid in determining whether selection for some traits in a breeding program will tend to have favorable or adverse effects on other traits.

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MATERIAL AND METHODS

Milk Characters

The data used were collected on purebred Milking Shorthorn cattle from a herd maintained at the Agricultural Research Center, Beltsville, Md., from 1932 to 1959 and from a herd maintained on the farm of the U.S. Northeastern Prison, Lewisburg, Pa., from 1953 to 1961. The herd at Lewisburg was established with animals from the Beltsville herd.

Five characteristics or traits associated with milk production were studied. These were (1) number of days milked, (2) percent of butterfat, (3) total yield of butterfat, (4) total yield of milk, and (5) total yield of fat-corrected milk. Only first calf heifer records were used both for dams and daughters in order to avoid the effects of selection. The heifers were milked two times a day.

Records were maintained beginning with the third day after freshening until the cow had milked 305 days or had dropped below 4.5 kg of milk per day (usually for at least 3 days). An effort was made to milk all cows at least 30 days even if they dropped below 4.5 kg per day; in a few cases this was not possible as they dried up before 30 days. Even then their record was used.

In the early part of the study, whenever possible, the first five heifers calving by each sire were tested. Later all heifers calving were milked and their records used. The milk was weighed daily at each milking both at Beltsville and Lewisburg. Butterfat percentage was determined by the Babcock test on 1 day each month. Older cows were used to nurse the calves.

From 1932 until 1951 all heifers at Beltsville were fed in drylot during their first lactation. They were fed 0.45 kg of a grain-protein supplement mixture for each 1.6 kg of milk produced per day and were fed all the silage and hay they would clean up. Beginning in 1951 at Beltsville and in 1953 at Lewisburg, heifers were turned on pasture in the summer in place of feeding silage and hay. They were fed grain as before.

Milk production was converted to a mature equivalent using Kendrick's (9) 5/ factors to adjust the age at freshening. Fat-corrected milk was calculated with the usual formula as follows: Total milk X 0.4 + total fat X 15 = total fat-corrected milk. On the basis of the monthly averages, the year was divided into two seasons of freshening: (1) November through May and (2) June through October.

5/ Underscored numbers in parentheses refer to Literature Cited, p. 15.

Records on 193 dams having 342 daughters with records were available. Heritability estimates for the milk production traits were obtained from a conventional daughter-dam regression analysis using in each case the difference between the individual's record and her contemporary herdmate's average (not including the individual) as the observation on the trait. Each deviation was weighted by multiplication by $n/(n+1)$ which is the reciprocal of the coded variance of that difference, where $\underline{n}$ is the number of contemporaries (herdmates). The genetic correlations among the five milk production traits were calculated as follows:

$$r_{G_iG_j} = \frac{\frac{1}{2}\,(\mathrm{Cov}\,G_iG'_j + \mathrm{Cov}\,G'_iG_j)}{[(\mathrm{Cov}\,G_iG'_i)\ (\mathrm{Cov}\,G_jG'_j)]^{\frac{1}{2}}} \tag{1}$$

where G_i is the genotype for the $_i$th trait of the dam and G'_i is the genotype for the $_i$th trait of the daughter and the subscript $_j$ refers to the other trait in the correlation. [Hazel (6), and VanVleck and Henderson (20)]. The covariances were estimated from all 342 daughter-dam pairs.

Beef Characters

All calves were reared to weaning by nursing. Most were multiple-nursed (two or more calves per cow). Calves were sometimes shifted from cow to cow in order to assure adequate milk. Before weaning the calves were creep-fed a grain-protein supplement mixture.

During the period 1932-51, 160 steers by 21 sires were raised and slaughtered at Beltsville. These calves were weaned at or close to 227 kg live weight. They were then fed individually in drylot to the limit of appetite on a grain-protein supplement mixture plus high-quality hay to a slaughter weight as near 408 kg as possible. Some variation in slaughter weight was unavoidable.

From 1951 to 1961 (the end of the experiment), steers were weaned at 150 days of age and thereafter were fed in groups on a limited concentrate ration of 0.23 kg of a grain-protein supplement mixture per day per 45 kg live weight until the ration reached 1.8 kg per head per day. The ration was held at that level until the animal was slaughtered at approximately 2 years of age. The steers were turned on pasture during the summer and were fed hay and silage ad libitum in the winter in drylot.

During the period 1951-61, 212 steers by 24 sires were produced. Of these 30 were raised and slaughtered at Beltsville, 94 were raised and slaughtered at Lewisburg, and 88 were raised during their first 6 to 12 months at Beltsville but transferred for their last 12 to 18 months to Lewisburg and slaughtered there.

At Lewisburg there was more variation than at Beltsville in adherence to exact ages or weights at which weights and measurement were taken. Rib samples from the steers slaughtered at Lewisburg were shipped to Beltsville for analysis. Some did not arrive in satisfactory condition so data from them were not included.

Production traits of post-weaning average daily gain, age at slaughter, and slaughter weight were included in the analyses for all steers. For the 160 steers fed to 408 kg at Beltsville, data on efficiency of gain expressed as gain per 100 pounds of total digestible nutrients (TDN) consumed was also studied. For the steers slaughtered at 2 years of age, 150- and 300-day weights were studied.

Carcass, meat, and growth traits are listed in table 1. They were generally evaluated according to methods outlined by AHOC (1) and by Hankins and coworkers (5). Dressing percentage and percentages of caul and ruffle fat and the four most valuable cuts were based on slaughter weight. Percentages of rib eye muscle, separable lean, fat, and bone and tendon were based on dissections of the 9-10-11 rib cut and were expressed as percentages of the weight of this cut. Palatability and tenderness determinations were based on eye muscle from the 9-10-11 rib cut heated to 60° C. Scores were either made on hedonic scales with higher numbers representing greater desirability or, in the case of a few traits, scored with lower numbers given for greater desirability. Signs of genetic correlation coefficients were reversed to this pattern so that positive genetic correlations represent, for example, more milk and a more desirable score. Since the Warner-Bratzer shear values are inversely related to tenderness, signs of the genetic correlations involving them were also reversed.

Method 2 of Henderson (7) was used to obtain estimates of heritability for all steer traits. Separate analyses were performed for steers of the two groups reared under different management systems as described earlier. Steer data were included only from a dam with a milk record and a sire who had two or more offspring in a given year and season.

Table 1.--Heritability estimates for meat production, carcass and growth traits (Calculated from paternal half-sib correlations. See text and footnotes for environmental adjustments)

Trait	900-pound steers (160 head, 21 sires)	2-year old steers (212 head)
150-day weight	(1/)	0.82 ± 0.29 2/
300-day weight	(1/)	.54 ± .26 3/
Average daily gain	1.49 ± 0.30 4/	.93 ± .29 3/
Efficiency of gain	.72 ± .35	(1/)
	.37 ± .35 4/	(1/)
Age at slaughter	.65 ± .34	(5/)
Slaughter weight	(5/)	1.05 ± .23 4/
Dressing, percent	.31 ± .30	.23 ± .22 4/
Slaughter grade	.40 ± .31	.75 ± .28
		.16 ± .21 4/
Carcass grade	.29 ± .29	.39 ± .23
		.10 ± .20 4/
Marbling score	.55 ± .33	.25 ± .23
		0.00 4/
Percent caul and ruffle fat	1.32 ± .39	.29 ± .23 4/
Length of body (carcass)	.59 ± .34	.05 ± .19 4/
Width at round	.01 ± .24	.76 ± .28 4/
Plumpness index of round	.24 ± .25	.26 ± .22
		.18 ± .21 4/
Percent most valuable 4 cuts	.58 ± .33	0.00 4/
Thickness of fat over eye of rib	.26 ± .24	0.00 4/
Percent ether extract fat	.67 ± .35	0.00 4/
Percent separable fat of rib cut	.33 ± .25	.09 ± .21
		0.00 4/
Percent eye of rib cut	0.00	0.00 4/
Percent separable lean of rib cut	.27 ± .26	.09 ± .21 4/
Percent bone and tendon of rib sample	.22 ± .29	.28 ± .23 4/
Muscle-bone ratio	.11 ± .26	.23 ± .23 4/
Shear test	.17 ± .27	.01 ± .19 4/
Tenderness score	.59 ± .34	0.00 4/
Desirability of flavor of lean	.15 ± .27	.31 ± .24
		.16 ± .22 4/
Intensity of flavor of lean	.63 ± .34	0.00 4/
Quality of juice	.67 ± .35	.30 ± .24 4/

1/ No data

2/ Not adjusted for time of castration age^2 at slaughter, 300-day weight and average daily gain.

3/ Not adjusted for age at slaughter, age^2, or 150-day weight.

4/ Not adjusted for variation in slaughter weight.

5/ Not calculated.

For the 160 steers fed to a final feedlot weight of 408 kg and slaughtered at Beltsville, constants were fitted for months, linear and quadratic regressions for years, and a linear regression for slaughter weight on a within-sire basis. Heritability of average daily gain was calculated without adjustment for slaughter weight. Heritability of efficiency of gain was calculated both with and without adjustment for slaughter weight and both estimates are given in (table 1).

For 2-year-old steers the model included sires, year-station subclasses, seasons, nursing treatments, parity groups, age at castration, linear and quadratic regressions for age at slaughter and linear regression for slaughter weight. Weights at 150 and 300 days of age and average daily gain were not adjusted for age at slaughter, and the 150-day weight was not adjusted for time of castration since all castration took place after this age. For most traits heritabilities were calculated both with and without adjustment for slaughter weight. In several cases, heritability appeared to be influenced by slaughter weight. In these cases, both estimates are given in table 1. For other traits only one heritability is given. Data were not available on all steers for all traits. Numbers of steers for each trait varied from 178 to 212. Progeny with records were available for either 23 or 24 sires for each trait.

In both groups of steers, heritability estimates for meat production traits were from paternal half-sib analyses. Estimates of genetic correlations between the milk and meat traits were obtained from the phenotypic correlations of the dam and son and from the heritability estimates. The formula used was derived from a path coefficient diagram assuming no environmental correlations and

$$r\,G_iG_j = \frac{2r_{P_iP'_j}}{g_ig_j} \qquad (2)$$

where $r_{P_iP'_j}$ is the phenotypic correlation between the milk production trait in the dam with the meat production trait in the steer progeny and g_i and g_j are the square roots of the heritability estimates for the two traits.

RESULTS

Milk Production Traits

Heritability estimates of the five traits associated with milk production were: Number of days milked 0.54 $\pm$ 0.14; percent butterfat 0.25 $\pm$ 0.13; total mature equivalent milk 0.45 $\pm$ 0.13; total manure equivalant butterfat 0.51 $\pm$ 0.13; and total mature equivalent fat-corrected milk 0.49 $\pm$ 0.13. Each of these was calculated with 342 pairs.

Number of days milked (length of lactation) was quite highly heritable in this study. Influence of lactation length may be a factor in the relatively high estimates for milk and fat yields observed. These are all in the range of 0.45 to 0.51 and are considerably higher than most estimates with dairy cows summarized by Rice and coworkers (16) as being in the range of 0.2 to 0.3. The estimate of 0.25 for heritability of fat percentage is lower than the range of 0.5 to 0.6 observed in most studies. However, the studies are not comparable in some respects. Many, if not most, of the earlier studies included no records which were under some arbitrary length limit such as 270 days. Some may have included records of more than 305 days in which effects of pregnancy might be expected to have a marked effect.

Estimates of genetic correlations among mature equivalent milk, mature equivalent butterfat, and mature equivalent fat-corrected milk are very high (table 2). Genetic correlations between percent butterfat and milk or fat yield are low. The genetic correlation between days milked and total mature equivalent milk production is intermediate at 0.60. No method of calculating an accurate standard error of these genetic correlations is known to the authors.

Table 2.--Genetic correlations between milk production traits

Item	Percent butterfat	Mature equivalent milk	Mature equivalent butterfat	Mature equivalent fat corrected milk
Days milked	-0.13	0.60	0.95	0.95
Percent butterfat		.03	.17	.10
Mature equivalent milk			.99	1.00
Mature equivalent butterfat				1.00

Calculated from daughter-dam covariances according to equation 1 using records of deviations from herdmate averages for the same station year and season.

Heritability of Carcass and Growth

Heritability estimates for the two groups of steers. Two heritabi at 408 kg were over 1.00 indicating bias in the data. In subsequent an to be 1.00. For the 2-year-old ste have been reported as zero.

ble 3.--Genetic correlations between milk production traits and meat, carcass, and growth traits for both groups of steers (Based on covariance of dam and steer progeny within sires)

ass, and raits	Milk production traits									
	Days milked		Percent butterfat		Total mature equivalent milk		Total mature equivalent butterfat		Total mature equivalent fat corrected milk	
	408 kg steers	2-year-old steers	408 kg steers	2-year-old steers	408 kg steers	2-year-old steers	408 kg steers	2-year-old steers	408 kg steers	2-year-old steers
ight	(1/)	-0.04[2/][3/]	(1/)	0.01[2/][3/]	(1/)	-0.24[2/][3/]	(1/)	-0.28[2/][3/]	(1/)	-0.31[2/][3/]
ight	(1/)	- .64[2/][3/]	(1/)	- .84[2/][3/]	(1/)	- .64[2/][3/]	(1/)	- .69[2/][3/]	(1/)	- .70[2/][3/]
verage daily postweaning gain	.17[2/][3/]	- .08[2/][3/]	- .42[2/][3/]	- .21[2/][3/]	.42[2/][3/]	.01[2/][3/]	.39[2/][3/]	.08[2/][3/]	.39[2/][3/]	.05[2/][3/]
Efficiency of postweaning gain	.15[2/] .22[3/]	(1/) (1/)	- .70[2/] - .94[3/]	(1/) (1/)	.61[2/] .84[3/]	(1/) (1/)	.40[2/] .58[3/]	(1/) (1/)	.57[2/] .79[3/]	(1/) (1/)
Age at slaughter	.12[2/]	(1/)	.60[2/]	(1/)	- .30[2/]	(1/)	- .21[2/]	(1/)	- .26[2/]	(1/)
Slaughter weight	(1/)	- .03[2/][3/]	(1/)	- .02[2/][3/]	(1/)	- .07[2/][3/]	(1/)	- .00[2/][3/]	(1/)	- .06[2/][3/]
Dressing percent	.62	- .03[3/]	.64	- .25[3/]	.07	.27[3/]	.04	.25[3/]	.14	.31[3/]
Slaughter grade[4/]	- .25	.25[2/] .57[3/]	.79	- .07[2/] - .16[3/]	-1.13	- .17[2/] - .39[3/]	- .87	- .04[2/] - .07[3/]	- .88	- .02[2/] - .04[3/]
Carcass grade[4/]	.41	.16[2/] .02[3/]	- .02	.30[2/] .61[3/]	- .33	- .14[2/] - .64[3/]	- .33	- .03[2/] - .34[3/]	- .27	.01[2/] - .34[3/]
Marbling score[4/]	- .04[2/]	.25 (5/)	- .62[2/]	- .46 (5/)	- .49[2/]	.13 (5/)	- .66[2/]	.04 (5/)	- .51[2/]	.13 (5/)
Percent caul and ruffle fat	- .20[2/]	.22[3/]	.21[2/]	- .04[3/]	- .69[2/]	.35[3/]	- .40[2/]	.22[3/]	- .51[2/]	.20[3/]
Length of body	.27[2/]	- .18[3/]	- .01[2/]	.29[3/]	.50[2/]	.20[3/]	.40[2/]	.26[3/]	.31[2/]	.28[3/]
Width at round[6/]	.87	- 10[2/][3/]	5.09	- .43[2/][3/]	3.68	- .04[2/][3/]	3.59	- .05[2/][3/]	3.70	- .06[2/][3/]
Plumpness index of round	- .50	.11 1.21[3/]	.62	.16 .26[3/]	- .95	.96 1.08[3/]	- .91	.99 1.14[3/]	- .68	1.00 1.14[3/]

Percent most valuable 4 cuts	.26[2/]	(5/)	.76[2/]	(5/)	- .28[2/]	(5/)	- .33[2/]	(5/)	- .20[2/]	(5/)
Thickness of fat over eye of rib	.12	(5/)	- .27	(5/)	- .40	(5/)	- .39	(5/)	- .32	(5/)
Percent ether extract fat	.28[2/]	(5/)	.03[2/]	(5/)	- .18[2/]	(5/)	- .17[2/]	(5/)	- .22[2/]	(5/)
Percent separable fat of rib sample	.16	.14 (5/)	.50	- .17 (5/)	- .46	- .02 (5/)	- .37	.28 (5/)	- .49	.25 (5/)
Percent eye of rib sample	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)	(5/)
Percent lean of rib sample	.24	.63[3/]	- .17	- .67[3/]	.42	.70[3/]	.54	.24[3/]	.57	.27[3/]
Percent bone and tendon of rib sample	- .71	- .37[3/]	-1.06	.66[3/]	.22	- .31[3/]	- .15	- .26[3/]	.05	- .24[3/]
Muscle bone ratio	1.14	.52[3/]	.90	- .93[3/]	.42	.43[3/]	.83	.08[3/]	.62	.26[3/]
Shear test[4/][6/]	.45	6.25[3/]	- .06	1.98[3/]	- .22	1.25[3/]	- .23	2.48[3/]	- .40	2.31[3/]
Tenderness score	.24[2/]	(5/)	- .35[2/]	(5/)	- .14[2/]	(5/)	- .43[2/]	(5/)	- .25[3/]	(5/)
Desirability of flavor of lean	.83	.63 .73[3/]	1.04	.76 1.08[3/]	1.03	.89 1.13[3/]	1.28	.83 1.08[3/]	1.15	.80 1.04[3/]
Intensity of flavor of lean	.00[2/]	(5/)	- .28[2/]	(5/)	.19[2/]	(5/)	.33[2/]	(5/)	.23[2/]	(5/)
Quantity of juice	.34[2/]	.39[3/]	- .52[2/]	.27[3/]	.67[2/]	.37[3/]	.54[2/]	.32[3/]	.53[2/]	.31[3/]

group or was controlled experimentally.
:heir standard errors.
nor in the case of 150- and 300-day weights for age^2 nor for age at castration in case of

:ales in which smaller numbers indicated greater desirability. Signs of genetic correlation
›ositive connotation; i.e., a genetic correlation indicating better carcass grades are
milk shows in the table as positive.
ł since one of the h^2 was negative.
ions may be due to very low heritabilities of width of round in the 408 kg steers and of

The heritability estimates in this study have rather large standard errors and thus undoubtedly vary considerably due to chance. Overall, however, those on the same or similar traits tend to be in general agreement with previously published estimates for beef cattle [see summaries by Warwick (20), and Petty and Cartwright (15)]. They fit the pattern of medium to high heritabilities for rate of gain, for efficiency of gain, and for measures of size and carcass fatness for animals fed on a high plane of nutrition. For animals on a lower plane of nutrition, the estimates tend to be more variable but are medium to high for measures of size and growth.

Genetic Correlations Between Milk Production Traits and Growth and Carcass Characters

Genetic correlations given in table 3 are for each group of steers. Correlations based on traits with heritabilities of 0.2 or larger and 1.6 or more times their standard errors have been identified as footnote 2. This is an arbitrary separation made in the absence of standard deviations for the genetic correlations. Sampling errors of the genetic correlations are of unknown magnitude but are undoubtedly large. Correlations numerically greater than 1.0 can be due to sampling error or to an environmental bias of unknown origin in the phenotypic correlation between dam's milk production trait and the growth or carcass trait of her son(s). It will be noted that several of the high genetic correlations involve carcass traits with extremely low heritabilities. This would magnify even small sampling errors in the phenotypic correlations.

In the steers reared to gain at rapid rates and slaughtered at about 408 kg, genetic correlations of total milk and butterfat production (including fat-corrected milk) with rate of post-weaning gain were positive. They were negative with age at slaughter indicating that higher producing cows tended to transmit greater than average growing ability to their sons. Feed efficiency was also positively correlated with milk and butterfat production as might be expected in view of the usual association of rate and efficiency of gain.

In the same group of steers genetic correlations between milk and butterfat production and factors measuring or indicative of carcass fatness were predominantly negative. These include slaughter grade, carcass grade, marbling score, percent caul and ruffle fat, precent separable fat of 9-10-11 rib sample, percent ether extract of eye muscle and thickness of fat over eye of the rib. Genetic correlations involving dressing percentage were positive but very low. Genetic correlations between total milk production and the two measurements of tenderness were low but negative.

Taken together, the above relationships fit the concept of cows with higher production potentials tending to transmit genes for faster growth and a below average tendency to fatten up to the relatively light slaughter weight of 408 kg.

Relationships of butterfat percentage and the growth and carcass traits in the same group of steers are less consistent but are mostly opposite (in sign) to those with total milk and butterfat production. Marbling score is an exception to this generalization.

In the steers reared on rations higher in roughage and slaughtered at 2 years of age, the genetic correlations of total milk and butterfat production with postweaning rate of gain are positive but very small and and with 150- and 300-day weights all negative. Genetic correlations of slaughter weight, which in cattle slaughtered at a constant age is a measure of lifetime gain, the total milk and butterfat are either zero or slightly negative. Other genetic correlations for the 2-year-old steers tend not to follow discernible patterns. Only a few are based on heritability estimates of 0.2 or higher and 1.6 or more times their standard errors.

DISCUSSION

Genetic relationships observed in Milking Shorthorn cattle in this study indicate that under intensive rearing conditions and a relatively light slaughter weight of 408 kg there is a positive genetic correlation between total milk and butterfat production and rate and efficiency of gain. There are negative relations with direct measures and most indirect indicators of carcass fatness. Percent butterfat in milk tended to be negatively related to rate and efficiency of gain and positively related to carcass fatness. It should be emphasized that none of the correlations are large enough to indicate that milk or butterfat production or butterfat percentage accounts for a major portion of the variance in production or carcass traits. Further, the statistical significance of the observed correlations is not known.

In steers reared on regimes making greater use of roughage and slaughtered at 2 years of age, genetic relationships between total milk and butterfat production and measures of growth and size were either very low or negative. This strongly suggests a difference in genetic relationships depending upon management and nutrition regimes.

Tyler (18) reviewed available evidence in the scientific literature on the relationships between growth traits and the production of milk and meat. From his review he concluded "...that the association between rate of growth (meat production) of males and milk production of close female relatives is not large." Tables 4 and 5 are adapted from Tylers review.

Several of the workers listed in tables 4 and 5 calculated genetic correlations between milk and meat traits. While generally larger than the correlations listed in the tables, few were statistically significant and are thus of questionable importance.

Table 4.--Correlations between progeny tests of bulls for milk yield of daughters and daily gain of sons 1/

Numbers of progeny groups	Correlation milk and daily gain	Breed	Country	Reference
9	0.13	Spotted Mountain	Germany	Bogner and Burgkart (3)
43	.27	Dairy Shorthorn	Great Britain	Mason (13)
49	- .05	Red Poll	do.	Mason (13)
33	.01	British-Friesian	do.	Mason (13)
41	.03	Red Danish	Denmark	Mason (13)
15	.06	Israel-Friesian	Israel	Bar-Anan and others (2)
25	.22	German-Friesian	Germany	Langlet (10)
23	- .03	Israel-Friesian	Israel	Soller and others (17)

1/ Average weighted by number of sire progenies 0.09.
Source: Tyler (18)

Table 5.--Correlations between milk production of cows and certain beef characters of their sons

Number of pairs	Daily gain	Daily Carcass gain	Dressing percent	Reference
1,320	-0.001	-0.02	-0.05	Mason (14)
136	.22	--	--	Martin and Starkenburg (12)
231	--	.13	--	Langlet (10)
450	.02	--	--	Soller and others (17)

Source: Tyler (18)

In 1972, Lazarevic (11) reported phenotypic and genetic correlations of several milk characters of 807 Red Danish cows with growth rates and concentrate conversion of their calves fattened to slaughter weights of 140 to 160 kg. Milk and fat yields had very low phenotypic correlations of 0.01 and 0.02 with weight gain while the phenotypic correlation of fat percentage with weight gain was -0.03. Milk and fat yield and concentrate conversion (units of feed per unit of weight gain) were negatively related phenotypically (-0.02 and -0.03, respectively). Relationships of milk characters with dressing percentage were low and inconsistent. Genetic correlations were higher than the phenotypic correlations for all traits but overall it was concluded "that the milk yield and fattening performance traits are mostly independent of each other..."

Hickman and Bowden (8) reported that growth from 180 to 240 days of age increased in both Holstein and Ayrshire herds selected for 180-day milk solids yield. The increase in the Holsteins was associated with increased feed consumption. There was evidence that the Holsteins became leaner. In both breeds there was an indication of a genetic trend toward a presumably optimum body weight and wither height.

Calo and coworkers (4) found a genetic correlation of 0.25 between milk production and growth rate of bulls to 15 months of age in Holstein-Friesians. Heritability of milk production was 0.19 and of 15-month weight 0.65 in their data. By using these estimates plus estimates of economic values of milk and beef traits, a selection index to maximize economic progress was developed. The probable consequences of varying emphasis on milk and meat traits in selection were explored. Relative genetic progress for both milk and meat traits was relatively high if meat traits received from one-third to one-half as much emphasis as milk production in selection programs.

On the basis of results found in the present study and those found in the literature, one can conclude that generally there is a positive relation between high milk production and rapid and efficient gain and

a negative one with dressing percentage. Most of the correlations are so low that for practical purposes they can be considered zero. However, the treatment the animals received in the present study appeared to have a marked effect so that moderately large correlations were obtained for the above comparisons with the steers raised to 408 kg on a fattening ration. The measures of fatness, in this study, tended to be negative with total milk and total fat production but positive with percentage of butterfat in the milk. None of the correlations are so high as to exclude ample potential for molding types combining wide spectrums of dairy-meat combinations with optimum emphasis in selection depending upon relative economic values of meat and milk.

The relationships may be greatly influenced by breed and intensity of rearing. It may be safe to generalize, however, that there are trends in directions which might be surmised from the historically different types which have developed in specialized beef and dairy breeds. These include tendencies for high milk and butterfat production to be positively associated to a low degree with rapid and efficient growth and negatively associated with ability to fatten at young ages.

SUMMARY

Genetic parameters of milk and meat production and their genetic interrelationships were studied in Milking Shorthorn cattle using records of 193 cows which had 342 daughters and of 372 steers from cows with milk records. Heritability estimates for traits related to total milk and butterfat production averaged about 0.49. Heritability of butterfat percentage was 0.25. Genetic correlations among different measures of total milk and butterfat production were high but were low with butterfat percentage.

Genetic correlations were positive between milk production and rate and efficiency of gain in steers full fed in drylot to 408 kg but negative with carcass fat production and related traits. There was a negative genetic relationship between milk butterfat percentage and rate and efficiency of gain.

With 2-year-old steers reared on pasture and growing rations, genetic correlations between milk production and growth from 150 days of age to slaughter were low as were genetic correlations between milk production and traits related to carcass fat.

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